Low-cost solar water purifier could bring fresh water to those in need

Using carbon powder, porous paper, and Styrofoam, researchers have made a device that uses sunlight to purify or desalinate water. The portable system generates fresh water 2.5 times as fast as a similar commercial product. The materials needed to build it cost about $1.60 per m^2 compared to $200 per 0.5 m^2 for commercial systems.

The low-cost technology could lead to large-scale systems that float on seawater and generate fresh water, or by people in developing countries to purify a few liters of dirty water a day.

Lack of potable water is one of the biggest health challenges around the world. Existing membrane technologies that purify or desalinate water work well, but are expensive and energy-hungry. Centuries-old solar distillation is better suited for decontaminating water in remote, impoverished areas or during natural disasters since it does not require electricity and is low-cost.

The idea behind solar distillation is to evaporate water in sunlight—pollutants and microorganisms stay behind—and then cool the vapors to collect pure water. Conventional solar stills are vessels coated with a light-absorbing black material and covered with glass or plastic covers that concentrate light. But over 60% of the sun's energy is lost in heating the large liquid volume, slowing down the process.

To increase efficiency, researchers added gold or advanced carbon nanoparticles to water to increase light absorption. Others took that a step further by infusing these nanoparticles on floating substrates made of carbon foam or nanoporous alumina so that sunlight only vaporizes the water surface, making the process more efficient. But the nanoparticles and the alumina substrates are too costly for making practical large-scale systems, says Qiaoqiang Gan, an electrical engineering professor at the University of Buffalo, The State University of New York.

So Gan and his colleagues started with cross-shaped porous paper that they covered with cheap carbon black. Then they took a 10 cm × 10 cm block of polystyrene foam and cut thin slits in it to make 25 square sections. They inserted 25 pieces of paper through the slits so that the top surface of the foam was covered with a 5 × 5 array of square carbon black paper, and the ends of the paper stuck out underneath the foam.

Finally, they covered the foam with a transparent, angled acrylic cover and placed the contraption on contaminated water. The foam floats and acts as an insulator, preventing sunlight from heating up too much water under the surface. All the paper pieces wick water to the foam surface, where it evaporates and condenses on the angled plastic cover and flows down into a collector.

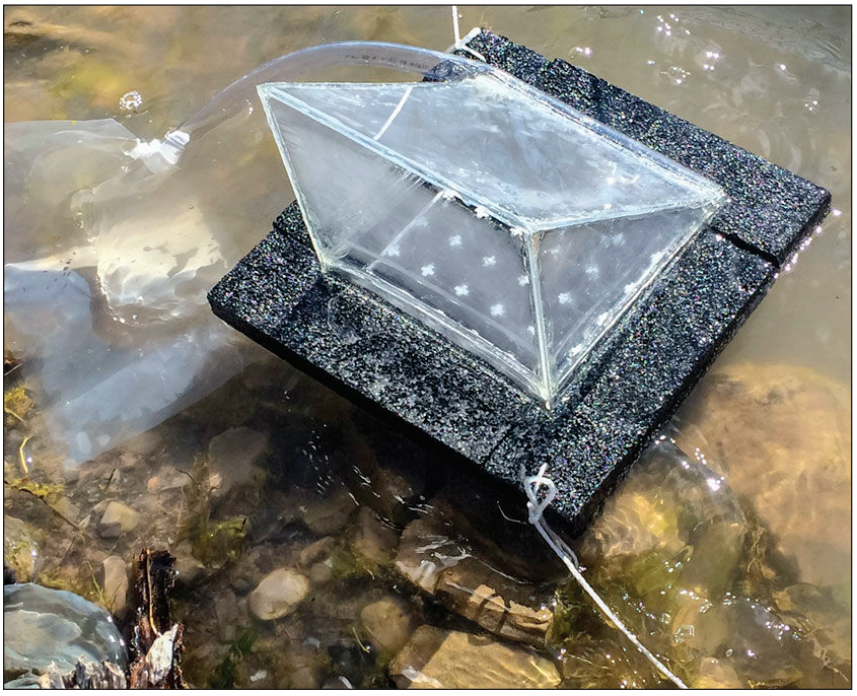
"Because we heat a very thin film of water rather than the entire bulk water, the energy efficiency is significantly improved," Gan says.

The researchers reported in the journal *Global Challenges* (doi: 10.1002/gch2.201600003) that the system uses 88% of the sun's energy to heat water. They also placed the system on a lake along with a $225 commercial solar still. After 10 hours in partly sunny conditions, the new carbon paper-foam system produced 3.5 cups of clean water, 2.4 times as much as the commercial one.

The researchers have founded a company and are now in talks with companies in South Africa, the United Arab Emirates, and some tropical countries to commercialize the work.

Freshwater scarcity is a pressing problem, and "it is nice to see that so many research groups worldwide are looking into direct solar steam generation to solve the complex problems and high energy costs of water treatment," says Naomi Halas, a professor of electrical and computer engineering at Rice University.

Prachi Patel



A prototype solar still made of low-cost materials such as carbon black, paper, and polystyrene foam floats on the surface of Lake LaSalle near the University at Buffalo. It can purify water 2.5 times faster than conventional stills. Credit: *Global Challenges*.

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